Electronic Version
Stylesheet Version v1.1.1

Claims

[c1] 1.- Method for canceling echoes and noises in environments with variable acoustic conditions and high feedback, such as the inside of an automated vehicle or of another class, for the purpose of permitting the establishment of a clear, audible communication between the occupants of the different areas of said vehicle, which can be implemented in a communication system integrating:

at least a first microphone (1) located in a first site, susceptible to receiving an existing original speech signal (5) so as to generate an electric signal from it and by means of several A/D , D/A converter, amplification and filtering means;

at least one speaker (3) prepared to receive said electric signal (13) and to transform it into an acoustic signal (7), susceptible to being received by said first microphone (1), together with a new original speech signal (5) and noise (9), both existing near said first site; and

an operative acoustic echo canceller system (15) using said electric signal (13), which will be reproduced, and an electric signal (10) supplied by the microphone and A/D converter means, this signal (10) comprising the

feedback of said reproduced acoustic signal (7), a new existing, original speech signal (5)and a noise (9) seized by the microphone, whose echo canceller system (15) is applied to remove said feedback,
characterized in that it carries out an additional filtering of an electric output signal (11) of said acoustic echo canceller system (15), resulting from the treatment of said signal (10) sent by the microphone (1), comprising a time variant filter applied to reduce the residual acoustic echo or echo tail that is not cancelled by the system (15) and those noise components from the inside of the vehicle, seized by said microphone (1), which is at least one, and present in said electric signal (11).

[c2] 2.- Method according to claim 1, characterized in that said communication system comprises at least one microphone and one speaker in the area of each one of a series of different areas of the vehicle among those which it is desired to establish audible communication, constituting several respective input-output channels.

[c3] 3.- Method according to claim 2, characterized in that said additional time variant filtering of said signal (11) is carried out by means of a two-stage Wiener filter (16), coupled in cascade, a first of them (22) applied to the elimination of a possible residual echo not suppressed by the echo canceller system (15) and a second stage

(23) intended to suppress the noise components (9) of the interior present in said signal (11), the calculation of the frequency response of both stages (22, 23) being carried out by a spectral power density estimate of said residual echo and by a spectral power density estimate of said noise present in said signal (11).

[c4] 4.- Method according to claim 3, characterized in that said power density estimate of the residual echo and the spectral power density estimate of said noise (9) existing in said signal (11) comprise the following stages:
storing M number of samples of said input signal (11) in a buffer memory (50), together with an M number (L-1) of samples of the same in a previous instant, ordered from the oldest to the most recent, the number M being set by the maximum permitted delay for auditory integration, in the passenger"s ear, between the sound received directly from the calling party and the reinforcement provided by the communication system;
weighting said LM samples in a window (51);
applying a fast Fourier transform in a stage (52), and smoothing the spectrum of said input signal (11) by means of a smoothing following a MEL type frequency weighting of the real and imaginary parts in respective phases (53a), (53b) so as to reduce the estimate variance from whose real and imaginary parts said spectral power

density of the input signal (11) to the Wiener filter (16) is estimated.

[c5] 5.- Method according to claim 4, characterized in that in the case of weighting the samples of the residual echo signal, the averaging time window (51) is short, whereas a long averaging time window is used for weighting the samples of the noise signal, which are more stationary than the speech signal.

[c6] 6.- Method according to claim 3, characterized in that by carrying out an initial attenuation phase (18) of the input signals (5, 7, 9) to each microphone (1) that are compensated with a proportional amplification stage (21) of the electric signal (13) sent to the corresponding speaker (3) for its reproduction after the suitable filtering and cancellation of echo tails and noises in said Wiener filter (16).

[c7] 7.- Method according to claim 2, characterized in that it also includes an automatic amplification gain control stage for the electric signals (12) after carrying out said additional filtering of echo tails and environmental noise, automatically controlled depending on the speed of the vehicle or other parameters such as the degree of opening or closure of the windows and because the final gain term applied to the system is a weighted time average

between a current volume variation value and an immediately previous volume variation value, such that the changes of volume are gradual.

[c8] 8.- Method according to claim 7, characterized in that said volume variation is set by both a minimum value when the vehicle is stopped and by a maximum value when the speed of the vehicle exceeds a certain pre-established speed.

[c9] 9.- Method according to claim 2, characterized in that it also includes an automatic amplification gain control stage for the electric signals (12) after carrying out said additional filtering of echo tails and environmental noise, automatically controlled depending on the level of the output signal (11) of the echo canceller (15) preventing saturation of the system against instabilities thereof.

[c10] 10.- Method according to claim 2, characterized in that it also includes an automatic amplification gain control stage for the electric signals (12) after carrying out said additional filtering of echo tails and environmental noise, controlled by the user through a panel of buttons.

[c11] 11.- Method according to claim 2, characterized in that the acoustic echo canceller system (15) comprises adaptive filters using a normalized LMS algorithm for the

modification of the filter coefficients whose values are adapted according to the transfer function between each output channel or speaker (3) and each input channel or microphone (1), such that the output-input feedback is cancelled through these transfer functions.

[c12] 12.- System for canceling echoes and environmental noises with variable acoustic conditions and high feedback, such as the interior of an automotive vehicle or of another class, permitting the establishment of a clear, audible communication between the occupants of different areas of said vehicle, which comprises:
at least a first microphone (1) in a first site, susceptible to receiving an existing original speech signal (5), and to convert it into an electric signal (13) by means of several A/D , D/A conversers, amplification and filtering means; and
at least one speaker (3) for receiving said electric signal (13) and to convert it into an acoustic signal constituting a reproducible, audible communication (7), which is fed back to said first microphone (1), together with a new original speech signal (5) and noise (9) existing in the area, said first microphone (1) and conversion means providing an electric signal (10); and
an operative acoustic echo canceller system (15) using said electric signal (13) which will be reproduced and an

electric signal (10) supplied by said first microphone comprising the feedback of said reproduced audible communication (7), a new existing, original existing speech signal (5) and other acoustic noise signals (9) existing in the area, whose system (15) is applied to eliminate the feedback of said audible communication (7) seized by said first microphone,
characterized in that it integrates an assembly applied to an further additional filtering of the electric signal (11) after leaving said acoustic echo canceller system (15) comprising a filter (16) varying in time applied to reduce the non-cancelled residual acoustic echo or echo tail and to suppress the noise existing inside of the vehicle which is seized by the microphones (1), whose echo and noise are present in said electric signal (13).

[c13] 13.- System according to claim 12, characterized in that it comprises at least on e microphone (1) and a speaker (3) in the area of each one of the different areas of the vehicle among which it is desirable to establish communication, constituting several respective input-output channels.

[c14] 14.- System according to claim 12, characterized in that said assembly applied to a filtering varying in time comprises a two-step Wiener filter (16), a first (22) of them applied to the elimination of a possible residual echo

that is not suppressed by the echo canceller system (15) and a second one (23) for carrying out the elimination of the noise in the area, whose two-step filter (16) is calculated by means of an estimate of the spectral power density of said residual echo and an estimate of the spectral power density of said noise, both existing in said signal (11).

[c15] 15.- System according to claim 12, characterized in that it comprises an attenuator (18) applied for attenuating said electric input signal (10) generated by each microphone (1) and an amplifier (2) applied for performing a proportional amplification of the electric signal (13) to be sent to the corresponding speaker (3) for the reproduction thereof after passing through said echo tail and noise canceling filter (16).

[c16] 16.- System according to claim 12, characterized in that it also includes a circuit for an automatic amplification gain control of the electric signals to be acoustically reproduced by the speakers, after said additional filtering, depending on the speed of the vehicle or other parameters such as the degree of opening or closure of the windows.

[c17] 17.- System according to claim 12, characterized in that it also includes an amplification gain control circuit (17)

for the electric signals to be acoustically reproduced by the speakers, after said additional filtering, whose circuit is adjustable by the user by means of several buttons.

[c18] 18.- System according to claim 12, characterized in that it also includes an amplification gain control circuit (17) for the electric signals to be acoustically reproduced by the speakers, depending on the signal (11) prior to said additional filtering.

[c19] 19.- System according to claim 12, characterized in that it integrates at least one DSP signal digital processor (33) having a series of A/D and D/A converters inputs associated to it for implementing all the digital filtering operations.

[c20] 20.- System according to claim 19, characterized in that it also comprises a mobile telephone terminal (39) associated to said DSP (33) for linking said terminal (39) to each one of the microphone-speaker (1-3) assemblies and permitting communication through it to each one of the persons in different areas of said interior of the vehicle, automatically controlled depending on the seed of said vehicle or other parameters such as the degree of opening or closure of the windows.

[c21] 21.- System according to claim 20, characterized in that

it includes an interface (35) including, for example, several control buttons available to the passengers for enabling/disenabling one or more microphones (1) and for recording a received or sent message.

[c22] 22.- System according to claim 12, characterized in that said acoustic echo canceller system (15) comprises several adaptive filters that use a standardized LMS algorithm for adapting the filter coefficients such that their values are adjusted according to the transfer function between each output channel or speaker and each input channel or microphone (1), such that the output-input feed back is cancelled through these transfer functions.

[c23]